

**Advanced Manufacturing National Program Office**

**Draft Institute Performance  
Metrics for the  
National Network for  
Manufacturing Innovation**

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[http://www.manufacturing.gov/docs/nnmi\\_draft\\_performance.pdf](http://www.manufacturing.gov/docs/nnmi_draft_performance.pdf)

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To learn more about the interagency AMNPO, visit [www.manufacturing.gov](http://www.manufacturing.gov)

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## Forward

The interagency Advanced Manufacturing National Program Office (AMNPO) is hosted by the National Institute of Standards and Technology (NIST). Creation of the AMNPO flows from the recommendation of the President's Council of Advisors on Science and Technology (PCAST) in its June, 2011, Report to the President on Ensuring American Leadership in Advanced Manufacturing,<sup>1</sup> that the Federal government launch a concerted, whole-of-government Advanced Manufacturing Initiative. To that end, this interagency office is charged with:

- Convening and enabling industry-led, private-public partnerships focused on manufacturing innovation and engaging U.S. universities, and
- Designing and implementing an integrated whole of government advanced manufacturing initiative to facilitate collaboration and information sharing across federal agencies.

By coordinating federal resources and programs, the AMNPO seeks to enhance technology transfer in U.S. manufacturing industries and help companies overcome technical obstacles to scaling up production of new technologies.

The National Network for Manufacturing Innovation (NNMI) program proposed by President Obama has the goal of advancing American domestic manufacturing.<sup>2</sup> The program will seek to accomplish this by creating a robust national innovation ecosystem anchored by a network of Institutes for Manufacturing Innovation. The NNMI will fill a gap in the innovation infrastructure, allowing new manufacturing processes and technologies to progress more smoothly from basic research to implementation in manufacturing. The NNMI program has a scale and focus that is unique, and it is built upon concepts of a strong public-private partnership.

## Abstract

Beginning in April 2012, a broad public engagement strategy by the Advanced Manufacturing National Program Office (AMNPO) was used to collect extensive input on the National Network for Manufacturing Innovation (NNMI or Network) program design. The collection of information from the public was initiated by a NIST Request for Information (RFI), published in the Federal Register<sup>3</sup>, followed by a series of regional workshops sponsored by AMNPO partner agencies and focused on the issues presented in the RFI. Reports summarizing the findings from the RFI and each workshop were published.<sup>4</sup> In January 2013, the *National Network for Manufacturing Innovation: A Preliminary Design* report was published, built upon public input received.<sup>5</sup> This AMNPO document utilizes the information gathered and provides draft performance metrics that can be used to evaluate the performance of Institutes for Manufacturing Innovation (Institutes) within the NNMI program, and that would apply to the NNMI

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<sup>1</sup> Report available at <http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast-advanced-manufacturing-june2011.pdf>.

<sup>2</sup> President Obama to Announce New Efforts to Support Manufacturing Innovation, Encourage Insourcing, <http://www.whitehouse.gov/the-press-office/2012/03/09/president-obama-announce-new-efforts-support-manufacturing-innovation-en>

<sup>3</sup> "Request for Information on Proposed New Program: National Network for Manufacturing Innovation (NNMI)," 77 FR 26509, May 4, 2012. Available at <https://federalregister.gov/a/2012-10809>.

<sup>4</sup> Reports are available at [http://www.manufacturing.gov/pubs\\_resources.html](http://www.manufacturing.gov/pubs_resources.html), and are listed under the "Advanced Manufacturing National Program Office (AMNPO)" heading.

<sup>5</sup> Available at [http://www.manufacturing.gov/pubs\\_resources.html](http://www.manufacturing.gov/pubs_resources.html).

and the Institutes that are created once appropriate legislation has been enacted.<sup>6</sup> This document is one of a series of documents generated to inform and seek feedback from the public on various elements that go into the creation and growth of the NNMI.

More specifically, this document describes draft metrics that can be used to help evaluate the performance and success of Institutes within the NNMI. These draft metrics were developed by an interagency team of experts, building on the initial metrics and lessons learned from the pilot institute, the National Additive Manufacturing Innovation Institute (NAMII). It is recognized that Institutes will vary considerably in their focus areas and perhaps in their structures as well; hence not all of the proposed metrics will be appropriate for all Institutes. However the six categories of draft metrics shown below are considered applicable to all Institutes:

1. Impact (1.1 – 1.4)
2. Industry Value (2.1 – 2.13)
3. Education and Workforce Development (3.1 – 3.6)
4. Portfolio (4.1 – 4.2)
5. Financial (5.1 – 5.5)
6. Network Contribution (6.1 – 6.4)

Within each broad category, several example metrics are given, and a short rationale is included for each. The examples are not intended to be comprehensive, and Institutes should be free to propose other metrics that are applicable to their particular focus areas. Among the example metrics, an effort was made to minimize the reporting burden. Some of the draft metrics are quantitative and some are qualitative. The example metrics also include items that are measurable in short, medium, or long time-frames.

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<sup>6</sup> Current proposed legislation includes: H.R.2996 entitled “*Revitalize American Manufacturing and Innovation Act of 2013*,” found at <http://thomas.loc.gov/cgi-bin/bdquery/z?d113:HR02996>., and the corresponding “*Revitalize American Manufacturing and Innovation Act of 2013*” introduced on August 1, 2013 by U.S. Sens. Sherrod Brown (D-OH) and Roy Blunt (R-MO).

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# Report

## A. INTRODUCTION

The draft performance metrics listed in this report are intended to be used to help measure the successes of the Institutes of Manufacturing Innovation (Institutes) that are a part of the National Network for Manufacturing Innovation (NNMI or Network). The metrics are intended to serve multiple purposes. This includes, as examples, performance measurement of an Institute, self-evaluation that could result in better management, and reports that convey information about Institute and NNMI impacts to a broad audience. Two characteristics can be assigned to each metric. One characteristic is whether the metric is quantitative or qualitative. The second characteristic is the time-frame over which a metric should be assessed. Table 1, at the end of this document, notes both characteristics for all metrics presented.

Institutes will vary considerably in their focus areas and perhaps in their structure, so all metrics may not be appropriate for all Institutes. However, it is anticipated that the six categories of draft metrics will apply to each Institute. The metrics categories are:

1. Impact,
2. Industry Value,
3. Education and Workforce Development,
4. Portfolio,
5. Financial, and
6. Network Contribution.

All Institutes will utilize these six categories of metrics. Some of the draft metrics are designated as “core,” indicating that they are common to all Institutes. Other metrics, designated as “example” may or may not be appropriate for a particular Institute, and Institutes could certainly propose alternate metrics of their own. The following Section presents both core and example metrics within all six metric categories.

## B. INSTITUTE METRICS

### 1. Impact

Impact metrics are intended to measure the broad impact of an Institute on U.S. manufacturing. The Institute’s impact on manufacturing innovation, employment, and the regional manufacturing ecosystem are particularly of interest.

Core and example Impact metrics include:

#### 1.1 Success stories and case studies (core)

Success stories may be difficult to quantify, but they are an excellent measure of the health of an Institute. The stories can provide a comprehensive look at how the investments in the Institutes and the Network have succeeded, and how the Institutes and the Network have achieved their missions. Success stories will vary between and within Institutes, but they should be easily understood, compelling, and supported by objective data. Success stories may combine information specifically available from other metrics in a way that provides a more complete picture, or they may add information not easily measured elsewhere.

Case studies tell the stories of particular activities undertaken by Institutes to address their missions. Case studies might include items such as:

- Tracking an innovation through the Technology Readiness Levels (TRLs) / Manufacturing Readiness Levels (MRLs) into a commercial product.
  - Identifying manufacturing innovations passing through the Institute

- Tracking the innovation into the marketplace as a new product or process, including lessons learned; noting what worked and what did not along the path to development (so others can learn from them, too)
- Documenting the impact of the new product or process on competitiveness (for example cost reduction, quality improvement, new market creation, etc.)
- Envisioning what future uses and impacts might be
- Documenting changes in technology ecosystems.
  - Companies whose business is within the focus area relocating near the Institute
  - Regional employment rates in the focus area
  - Job creation in the sector beyond the region
  - Company testimonials
  - Federal agency benefits
  - Hiring at regional educational institutions in support of the focus area
  - Technical ecosystem expansion
- Tracking evolving industrial interactions.
  - Identifying the reasons a company became involved with an Institute
  - Tracking the value perceived by partner companies
  - Measuring the number of hires made through the Institute
  - Measuring intellectual property (IP) licensing

## **1.2 Number of jobs created and retained (core)**

As far as is practical, this metric should include only jobs directly attributable to the effects of the Institute. This is a statistic that is more readily available from partner companies, but which may be difficult to quantify beyond the partners. Trends may be available such as

- Regional employment rate
- National employment rate
- Number of graduates from universities, community colleges, and training programs who find employment in the sector

## **1.3 Number of Institute technologies reaching commercial production (example)**

This metric consists of tabulating and tracking the TRL / MRL of the technology over the life of the Institute. This metric addresses the Institute mission to move innovation from basic research to commercial application.

## **1.4 Transitioning efficiency through the TRL / MRL levels (example)**

Some of the technologies that pass through an Institute will reach commercial applications quickly, some more slowly, and some not at all. A high-performance Institute will improve the efficiency at which new technologies progress within and between TRL / MRL levels, reach the marketplace, and compete internationally.

## **2. Industry Value**

Industry Value metrics are intended to measure the extent to which the industrial partners perceive that they are receiving value from the existence of the Institute. They measure the industry view of the appropriateness of the selected focus area and of the structure and operation of the Institute.

Core and example Industry Value metrics include:



## **2.1 Level and quality of co-investment by non-federal sources (core)**

This metric enables evaluation of how well the focus area of the Institute matches a real national need. Non-federal partners dedicate resources when they believe that there will be economic benefit. Non-federal sources include cash and in-kind provided by industry partners of all sizes, state and local governments, economic development entities, institutions of higher education, private organizations and individuals.

## **2.2 Trend of co-investment by non-federal sources (core)**

In a successful Institute, there must be strong partner co-investment. The co-investment requirement is not trivial, and at the start of an Institute there must be sufficient commitment to warrant the award. Even so, as time goes on, the level of non-federal investment should increase. As the Institute demonstrates success and value, it is expected that new partners will engage, and existing partners will increase their level of engagement.

## **2.3 Ratio of received to originally committed co-investment (example)**

In the proposal phase, partners may commit support to an Institute that would be spread over a number of years. The magnitude of these commitments as measured in financial, personnel, and resource services will be as important as the number of the commitments at all stages of an Institute's lifecycle. If an Institute is successful, the ratio of received to originally committed co-investment will grow. If the Institute is not successful, the number of partners and the size of their investments will diminish and the ratio will drop.

## **2.4 Total number of partner companies (example)**

If a broad industrial base recognizes value in an Institute focus area and sees positive impacts from Institute activities, then many companies will want to be partners.

## **2.5 Number of partner companies by size (small, medium, and large) (example)**

Successful Institutes will need partners of all sizes. Historically, many innovations make it to the shop floor or marketplace through the efforts and growth of small and medium-sized SMEs) companies that are very cash limited. Hence the Institutes will need significant and sustained monetary support from large industry members.

## **2.6 Trend in total partner companies (example)**

Partner companies may come and go depending on their financial situations, perceived value from the Institute, personnel changes, etc. In a successful Institute, it is expected that the number of partner companies will increase from initiation but will nominally stabilize over longer time periods.

## **2.7 Growth in partner companies by size (example)**

Growth in a large company could be used, for example, as an indicator of stable and reliable long-term funding. Growth in SMEs could be used as an indicator of dynamic innovation deployment.

## **2.8 Total number of retained partner companies (example)**

Partners who return with new projects, who continue to provide funding and other resources, who continue to hire from an Institute are an indication of the success of the program. Failure of companies who join at the start to continue their participation could indicate a problem. A reasonable measure might be the yearly ratios of partners from prior years who continue to participate to those who do not.

## **2.9 Number of retained partners by size (example)**

Institutes need to retain participation of large company partners for stability and SMEs for growth and dynamism.

#### **2.10 Investment by partners in advanced manufacturing innovation (example)**

It is expected that Institutes will encourage not only partner investment in the Institute activities, but will lead to increased investment in advanced manufacturing innovation by the partner. Measures that may be used as a proxy of a partner's increased investment in innovation can be improvements in R&D investment, an increase in products developed, and changes in IP developed and/or licensed, as examples.

#### **2.11 Number of companies making use of Institute facilities (example)**

It is expected that Institutes will have unique and advanced facilities compared to their partners and that companies in the ecosystem will want to use the Institute facilities, whether they are partners or not. The uses might include:

- Fee for service
- Participation in training
- Number of startup companies incubating in the Institute.

#### **2.12 Number of spin-off companies created (example)**

Innovations from the Institute could be absorbed by partner companies or may lead to formation of new companies. The latter is particularly true if the innovation is disruptive in some segment. Spin-off companies may provide a means to prove the commercial value of a new innovative technology.

#### **2.13 Supply Chain Engagement and Development (example)**

A robust supply chain is critical to continued expansion of technology transition. As the number of technologies transitioned increases, it is expected that Institutes will actively seek to establish or expand supply chains. Measurement of supply chain engagement and development is possible. Opportunities exist to partner with the NIST Manufacturing Extension Partnership (MEP) Program (<http://www.nist.gov/mep/>) to develop metrics in this area. The NIST MEP Program surveys clients to measure jobs created, jobs retained, change in sales, investments leveraged, and cost savings. This knowledge could be expanded to reflect and measure supply chain engagement and development.

### **3. Education and Workforce Development**

The Institutes will have a mission to increase and improve the workforce prepared for advanced manufacturing jobs. This group of metrics is intended to measure success in this mission across a broad spectrum of activities.

Core and example Education and Workforce Development metrics include:

#### **3.1 Number of partner and of non-partner professionals participating in research, education, and training (core)**

A successful Institute will provide opportunities and programming for education and workforce development. These activities will improve the manufacturing climate in the broader community and draw new partners to the Institute. It is expected that these activities will be interesting not only to partners, but to non-partners as well. Examples of metrics include:

- Number of non-partner attendees at workshops and short courses. The workshops and short courses could be created by Institute staff or they could be related to the focus and simply hosted at the Institute.

- Number of undergraduate students, graduate students, or post-docs drawn from outside the partner institutions to work on the Institute's focus areas.
- Participants from the non-technical community in open-houses, demonstrations, science fairs, Engineer's Day, etc.

### **3.2 Number of university students participating in research, education, and training (core)**

It is expected that the Institutes will draw students, particularly from the partner educational institutions, to work in the Institute. Geographical proximity would allow part-time work, student projects, shadowing, and the like. Also, the use of facilities during courses, either in-person or remotely using distance learning technologies, will indicate the educational impacts of the Institute.

### **3.3 Number of community/technical college students participating in research, education, and training (example)**

It is expected that the Institutes will provide practical exposure to state-of-the-art facilities for community/technical college students, and facilitate pathways for students to learn about educational options that might best suit their long-term interests and capabilities. Institutes and community/technical colleges will promote various technical engagement opportunities including course and work participation. It is expected that institutes will leverage geographic proximity, established regional and professional networks, and forge new relationships.

### **3.4 Number of K-12 students and teachers participating in research, education, and training (example)**

Institutes will have a central role in improving the image of manufacturing. Showcasing the activities of the Institute and partner companies to K-12 students, teachers, parents, and families builds recognition for the interesting, challenging, rewarding careers in manufacturing. It is expected that Institutes will provide easy access for tours, and the Institutes will engage in outreach activities.

### **3.5 Number of veterans participating in research, education, and training (core)**

One of the NNMI missions is to tap the talent pool of military veterans. Institutes will provide workforce development programs with specific attention to veteran needs including: certifications, educational opportunities, skills redirection, and others as examples.

### **3.6 Number of certification and degree programs created in collaboration with colleges, universities, and professional organizations (core)**

In addition to providing training and education, Institutes will help develop new and expanded certifications, training programs, degree programs, and other educational opportunities. Institutes might make available examples of course materials that could be developed by Institute members (e.g., lecture materials and homework problems) in the context of undertaking technology development at the Institute. These course materials can be made available to educators to provide real-world content for their curricula.

## **4. Portfolio**

This group of metrics is intended to measure the breadth and depth of projects contained in the Institute portfolio and to track progress toward completion of project objectives.

Core and example Portfolio metrics follow:

### **4.1 Number of projects in the portfolio (core)**

A well-functioning Institute will have a portfolio of projects that is broad and deep. Through the life of the Institute, some projects will move out into the commercial world, some will terminate, and new

ones will arise. It is expected that the number of projects will grow in the beginning and stabilize at a level that is appropriate for the focus area and size of the Institute.

#### **4.2 Number of project-level metrics achieved (example)**

Each of the projects pursued by an Institute will have measurable outcomes. It is expected that the Institute will make consistent progress in achieving the metrics, or projects should be terminated.

#### **4.3 Number and value of IP products produced and licensed (core)**

This metric includes patents, provisional patents, trade secrets, copyrighted works, and generally, any form of IP. Institutes will be free to set their own IP policies, consistent with the published IP guidance and to use them as a means of encouraging companies to join, especially SMEs. For example, an Institute can consider tiered royalty rates within the Institute (all members pay some, so some funds flow to the inventors and some to help the institute become self-sustaining) and without (non-members pay more for IP).

### **5. Financial**

Institutes need to establish stable revenue streams that will lead them to self-sufficiency after the initial NNMI funding expires. While many long-term funding models are possible, Institutes should demonstrate progress toward self-sufficiency.

Core and example Financial metrics follow:

#### **5.1 Ratio of membership dues income to Institute expenses (core)**

One source of on-going revenue for an Institute could be dues paid by partner organizations. The ratio of dues income to Institute expenses could be a measure of transition toward sustainability.

#### **5.2 Level of fees for services or publications (core)**

Because the Institute will have unique equipment and capabilities, potential revenue stream could be realized from fees-for-services. The Institute's unique capabilities may also lead to revenue generating publications and fee-based documents.

#### **5.3 Level of non-federal funding (core)**

An Institute may perform work under contracts with both member and non-member organizations, though the terms of the contract may vary depending on the membership status of the organization. In addition, an Institute may be successful in obtaining non-federal funding from various sources through grants or other agreements. Thus the revenue stream an Institute is able to generate through contracts and non-federal funding will help to measure the Institute's progress toward self-sufficiency.

#### **5.4 Level of non-NNMI federal contracts and grants (core)**

Federal funding for the NNMI is time limited by design. Institutes are intended to become self-sufficient, meaning not dependent on further NNMI funding. However, Institutes can compete for non-NNMI funding from federal sources. The success of an Institute in securing other federal funding, whether in number of awards or dollars, may be a useful indicator of the value of the Institute to agencies and their missions. .

#### **5.5 Level of Intellectual Property (IP) revenue (core)**

This metric may be stronger for some Institutes, and less so for others. IP revenue can come from:

- Direct IP licensing

- The rise in value of a start-up company where the Institute has an equity stake (in exchange for the IP)
- Increased participation in the Institutes by member companies benefiting from the IP produced.

## **6. Network Contribution**

Each Institute is a member of the larger NNMI. The interaction of Institutes through the Network will amplify the benefit beyond what any Institute could achieve alone.

Core and example Network Contribution metrics follow:

### **6.1 General Interaction with the larger Network of Institutes (core)**

A successful Network relies on a multitude of interactions between the individual Institutes and the Network. The interactions include sharing best practices, sharing case studies, building common legal and management frameworks (to the extent possible), and sharing aggregated financial and technical performance information.

### **6.2 Number of referrals of projects or partners to other Institutes in the Network (example)**

Institutes will have an understanding of unique skills, capabilities, and services other Institutes possess within the Network, and they therefore can serve an important role in referring potential partners to the most appropriate Institute for their interests. The number of referrals received and that lead to substantive joint activities within the Institute would be a measure of Institute and Network performance.

### **6.3 Number of projects or partners received from other Institutes in the Network (example)**

By strongly communicating their focus areas to other Institutes, an Institute can better attract referrals from across the Network.

### **6.4 Institute participation in Network governance (core)**

Institute participation in Network activities on a regular basis will strengthen the Network, may strengthen the performance of the Institute, and would be an indicator of the Institute's leadership. Consequently, contributions made by an Institute to the governance of the Network should be assessed using qualitative and quantitative methods.

**Table 1      Classification of Metrics**

| <b>METRIC<br/>CLASSIFI-<br/>CATION</b> | <b>Short Time Frame</b>   | <b>Medium Time Frame</b>   | <b>Long Time Frame</b>   |
|--|---|--|--|
| <b>Qualitative</b>                     | 1.1   2.13       4.2       6.1<br>6.4   | 1.1   2.13       4.2       6.1   | 1.1                   4.2       6.1  |
| <b>Quantitative</b>                    | 2.1   3.1   4.1   5.1<br>2.3   3.2   4.3   5.3<br>2.4   3.3<br>2.5   3.4<br>2.10   3.5<br>3.6 | 1.2   2.2   3.1   4.1   5.1   6.2<br>1.3   2.3   3.2   4.3   5.2   6.3<br>2.4   3.3           5.3   6.4<br>2.5   3.4           5.4<br>2.6   3.5           5.5<br>2.7   3.6<br>2.8<br>2.9<br>2.10<br>2.11<br>2.12<br>2.13 | 1.2   2.2   3.1   4.1   5.1   6.2<br>1.3   2.3   3.2   4.3   5.2   6.3<br>1.4   2.4   3.3           5.3   6.4<br>2.5   3.4           5.4<br>2.6                   5.5<br>2.7<br>2.8<br>2.9<br>2.10<br>2.11<br>2.12<br>2.13 |